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Exposure to Influenza Virus Aerosols in the Hospital Setting: Is Routine Patient Care an Aerosol Generating Procedure?

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We read with interest the article by Bischoff et al, in which they describe detection of influenza virus in aerosols around hospitalized patients with influenza virus infection who were receiving routine care [1]. As the authors note, current World Health Organization and Centers for Disease Control and Prevention guidelines for protection of healthcare professionals from influenza virus infection rely on the supposition that, under routine conditions, most transmission occurs via large droplets, rather than via small-particle aerosols [2, 3]. Under these guidelines, aerosol transmission is presumed to be limited to certain aerosol-generating procedures (AGPs), for which higher-level respiratory protection is recommended. The designation of AGPs has been made in large part by extrapolation from epidemiologic studies of outbreaks of other respiratory infections, such as tuberculosis and SARS coronavirus infection [4]. Whether such procedures are uniquely associated with generation of potentially infectious aerosols has not been established.

As part of a pilot study, we recently enrolled patients with and those without respiratory infections who were undergoing potential AGPs at a tertiary-care hospital. All patients provided written informed consent. We included patients with documented influenza virus infection during periods when they were undergoing mechanical ventilation and/or during periods when they were breathing on their own. We sampled air within 0.91 m (3 feet) and 1.83 m (6 feet) of the patient and outside the room for 3.25 hours, using National Institute for Occupational Safety and Health 2-stage aerosol samplers [5]. Aerosol sampling was also performed for 1 to several minutes near the patient's mouth, using closed-faced filter

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cassettes during extubation, suctioning, and use of an incentive spirometer. Influenza virus RNA copy number was determined by polymerase chain reaction (PCR), and the mean value of 2 replicates was used in analysis.

Variability in influenza virus RNA–laden aerosol generation was evident. The experience of one patient with influenza diagnosed on hospital day 1 by PCR of bronchoalveolar lavage fluid is informative (Table 1). On hospital day 2, we obtained samples while the patient was breathing with the assistance of a mechanical ventilator. On hospital day 3, we obtained samples during extubation and subsequently while the patient was breathing on his own. On hospital day 4, we again obtained samples while the patient was breathing on his own. On each day, influenza virus RNA was detected in particles of respirable size, but a relationship to what we considered to be potential AGPs (mechanical ventilation, suctioning, extubation, and use of an incentive spirometer) was not evident. Indeed, potential respiratory exposures to healthcare professionals in the room appeared highest on hospital day 4, when the patient was breathing on his own and care was routine. Interestingly, the highest concentration of influenza virus RNA copies observed during these 3 days of sampling occurred on hospital day 3, outside of the patient's room. Although genetic comparison to the patient's virus was not performed, the pattern suggested a source of influenza virus other than the patient and underscored the challenges of studying and controlling influenza virus transmission in the hospital setting.

Bischoff et al found that the majority of influenza virus RNA was contained in small particles. This observation corroborates previous work [5–7] and raises the possibility that aerosol transmission of influenza virus may occur during routine patient care [8]. Looking forward, by better characterizing the risk of infection when influenza virus–laden aerosols are generated, such as verifying the infectivity of virus found in small particles and/or demonstrating an increased risk of influenza virus infection among healthcare professionals due to small particle aerosols, future studies may prompt a reconsideration of current guidelines for protecting such individuals from influenza virus infection. Yet as our experience suggests, multiple sources of influenza virus are possible in healthcare settings, and some of these sources (whether they are patients, fellow healthcare workers, or visitors with undiagnosed infection) will go unrecognized. Thus, use of preventive measures that do not require source recognition, such as vaccination, will remain of paramount importance.

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Table 1

Results of Air Sampling Near a Patient With Influenza

	Influenza A Virus Load, Copies/m^3 of Air		
Sampler Location, Height, Stage	**Hospital Day 2**	**Hospital Day 3**	**Hospital Day 4**
Head of bed[a]			
1.52 m			
First (>4 μm)	Not detected	Not detected	826
Second (1–4 μm)	216	Not detected	983
Filter (<1 μm)	Not detected	112	Not detected
Total respirable (<4 μm)	216	112	983
1.02 m			
First (>4 μm)	Not detected	Not detected	Not detected
Second (1–4 μm)	414	Not detected	Not detected
Filter (<1 μm)	Not detected	Not detected	Not detected
Total respirable (<4 μm)	414	Not detected	Not detected
Right of bed (1.83 m from patient)			
1.52 m			
First (>4 μm)	32 770	Not detected	26
Second (1–4 μm)	Not detected	Not detected	29 887
Filter (<1 μm)	Not detected	Not detected	Not detected
Total respirable (<4 μm)	Not detected	Not detected	29 887
1.02 m			
First (>4 μm)	Not detected	Not detected	Not detected
Second (1–4 μm)	Not detected	Not detected	2085
Filter (<1 μm)	Not detected	Not detected	Not detected
Total respirable (<4 μm)	Not detected	Not detected	2085
Outside room			
1.52 m			
First (>4 μm)	Not detected	Not detected	Not detected
Second (1–4 μm)	Not detected	3844	44
Filter (<1 μm)	Not detected	Not detected	Not detected
Total respirable (<4 μm)	Not detected	3844	44
1.02 m			
First (>4 μm)	Not detected	Not detected	Not detected
Second (1–4 μm)	Not detected	329 152	141
Filter (<1 μm)	Not detected	Not detected	53
Total respirable (<4 μm)	Not detected	329 152	194
Near patient mouth during suctioning			
0 m			

	Influenza A Virus Load, Copies/m^3 of Air		
Sampler Location, Height, Stage	**Hospital Day 2**	**Hospital Day 3**	**Hospital Day 4**
Filter	Not detected	Not done	Not done
Near patient mouth during extubation			
0 m			
Filter	Not done	Not detected	Not done
Near patient mouth during spirometer use			
0 m			
Filter	Not done	2913	Not done

On hospital day 2, patient was breathing with the assistance of a mechanical ventilator. On hospital days 3 and 4, patient was breathing on his own. The lower limits of detection and quantification by quantitative polymerase chain reaction were 10 and 15 copies, respectively.

[a]The sampler was located behind the patient's head. This location was chosen to limit interference with clinical activities, but it may have contributed to the relatively low number of influenza A virus copies in the larger stage (≥4 μm).